AMERICAN
FOREST &
PAPER
ASSOCIATION

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To: Prospective Researcher

In 1994, the American Forest & Paper Association (AF&PA) released "Agenda 2020: A Technology Vision and Research Agenda for America's Forest, Wood, and Paper Industry." That document described in general the research needed by the forest products industry to allow it to pursue a sustainable future.

At the request of the AF&PA Sensors and Control Operating Task Group, we are writing to you requesting two-page proposals for research to be funded by the US Department of Energy in October 1999 for federal fiscal year 2000. The two page proposals must be received by August 1, 1998.

The Sensors and Control Operating Task Group is encouraging proposals submitted as a result of collaboration, or alliances between varied disciplines (such as collaboration between universities and the industry and/or its suppliers, between universities and national labs, etc.). If you feel this letter does not apply to your field of research, please do not hesitate to pass this along to someone who is experienced in this area.

We look forward to your response.

Attachments:

Five Research Priorities
Sensors & Control Funded Proposals List
Pre-proposal Form
Sensors & Control Pathways

I. Background

Now that the task of identifying 1998 projects to recommend for 1999 funding by DOE is done, the Agenda 2020 Sensors and Control Operating Task Group, chaired by Dr. Sanford Levy of Union Camp Corporation and Dr. G. Ronald Brown of Westvaco Corporation, have begun work on their part of the 2000 program recommendation. As they seek to improve the process, they have redefined the industry's needs in this area in a series of identified specific high priority sensors and control research areas.

II. The Proposal Submittal and Selection Process for 1999

- Two- page (single-sided) preproposals using **Attachment 2** form must be received by August 1, 1998. **Late proposals or proposals more than two pages will not be considered**.

- The best of these proposals will be selected using the criteria listed below in October. Selected researchers will be requested to prepare a final 5-page proposal.

- Those requested to prepare a final 5-page proposal will be invited to participate in a meeting describing their proposal. This session will be held December 3, 1998 in Chicago.

- The 5-page proposals must be received by February 1, 1999. **These proposals must include identification of the specific sources of at least 20% cost shared funding and represent a quantified energy benefit**.

- The Sensors & Control Operating Task Group will review these proposals, and make recommendations to the AF&PA Chief Technology Officers Working Group in Spring 1999.

- **In making its selections, the Task Group will use the following four (4) criteria:**

    1. Quality
    2. Total Value and Return
    3. Probability of Success
    4. Overlap of Current Technology

- **Submissions must include 20 copies of two page proposals**. They should be sent to:

Regular & Overnight mailing address:

Susan Malizia
AF&PA
1111 19th Street, NW, Suite # 800
Washington, DC 20036
Tel: 202-463-5178 Fax: 202-463-5180*

**Please send a hard copy with any fax submission*

III. Sensors and Control Areas Target for 1999

In the following material, you will find discussions of 5 topics on which the AF&PA Sensors and Control Operating Task Group is interested in receiving proposals.

SENSOR AND CONTROL RESEARCH AREAS

Introductory Remarks: The attached research pathways are provided to give you a better understanding of the five priority areas selected. The Task Group identified five topics in the pulp and paper product areas as having a higher priority for research in 2000. These are laid out in the following text. As technology develops, and work is completed, these research priorities will change. The "pathways," including research directions, define in general terms where there is continuing research. These are a general guide and are not intended to be a substitute for a complete literature search in your field of interest.

As you prepare proposals, there are 5 considerations which must be understood. First, Agenda 2020 is clear in its requirement that this research be "pre-competitive". Second, the research must be broad enough to help us bridge from where we are to where we need to go. Third, the cost of the technology (to a mill or a company) must have the potential of providing an economic return when the technology is fully commercialized. Fourth, there must be a quantified energy benefit. Fifth, 20% of full project funding is required by a non-government source.

1. Pathway for Addressing Industry Sensors & Control Needs Related to Final Control Elements (Pathway #1)

Reducing variability in manufacturing processes and the consequential variability in paper products is a continuing focus in the pulp and paper industry. Paper and board customers continue to demand more uniform products that perform similarly from sheet to sheet, roll to roll, and shipment to shipment. Paper variability exists on several levels. On a centimeter scale, fiber distribution in the plane of the paper is nonuniform, and is influenced by fiber size, fiber flexibility, and aspects of the papermaking process. On larger scales, fiber distribution can be affected and controlled by existing technologies, although further improvement will be desired in the future.

C More Uniform Fiber Distribution

A target research area is development of final control elements that will make possible more uniform paper and board products with more consistent mass distribution of fibers throughout the plane of the sheet. Existing control devices allow control of fiber distribution in zones across the width of a paper machine that are approximately three inches wide. Persistent streaks and nonuniformities have been noted that are smaller that this scale and which are critical in the performance of paper and board products. New final control elements for the forming section of paper machines are desired that will facilitate control of fiber mass distribution in the plane of the paper web on a centimeter-scale.

2. Effective Process Measurement/Monitoring Sensors (Pathway #2)

C Non Process Elements

As mill operations strive to further decrease usage of fresh water from current levels, non-process elements within our manufacturing process will increase in concentration. These components can have negative impacts on process chemistry, scale formation, and process efficiency. We can best adjust our operating conditions to better purge, dilute, or reduce the formation of these materials if real time measures of their concentration are available. We would like to support the development of sensor technology to track these non-process elements, including: calcium, phosphorus, and chloride ions. Other high priority materials include manganese, magnesium, oxalate, and iron. In addition, there is a need to measure the amount of methanol present in the liquid phase so that potential vapor emission levels can be predicted.

These sensors are needed primarily for application in pulping, bleaching, and chemical recovery process areas. Sensors need to operate reliably in the harsh temperature and pH conditions found in these environments. Reliability and minimal maintenance support are critical for successful mill installations. If consumable materials are a component in the sensor system, then the replacement frequency should not be less than weeks or months. Energy benefits can be identified in our ability to reduce: purge flows, fresh water usage, heat transfer surface fouling, chelant requirements, and undesired chemical reactions.

C Wet End Chemistry

For many paper products, chemical additives are blended with pulp fibers before papermaking to improve drainage, fiber distribution, retention of fine fiber fragments and filler pigments, sheet strength, or water repellency. The electrokinetic properties of the blended furnish have a dramatic impact on process efficiency and product characteristics. Changes in operating parameters and furnish components can quickly move the furnish from an acceptable electrokinetic range to one that is not acceptable, with undesirable results. The paper machine operators often do not understand the root causes of changes that occur because on-line measurements are not available to characterize colloidal interactions and furnish electrokinetic properties. Laboratory techniques exist for measuring colloidal charge, colloidal charge demand, or zeta potential, but they are not robust enough for on-line application. A target research area is development of a reliable, affordable real-time sensor for measurement of colloidal charge or colloidal demand at the wet end of a paper machine.

C Pulp Properties

Paper quality is directly related to papermaking parameters and raw material properties. Therefore, the characteristics of the pulp produced in the pulp mill and bleach plant are critical to the efficient production of high performing paper. To allow for real-time monitoring and control of the key pulp attributes, sensor systems are essential. The critical properties of pulp that are the focus of this RFP are: strength (zero-span tensile), fiber bonding, fiber damage (kink and curl), and dirt content. Although laboratory techniques exist for the measurement of these properties, no acceptable on-line technology is currently available.

3. Measurement for Product Improvement (Pathway # 2)

C Prediction of Print Quality

In the area of measurement for product improvement, a continuous prediction of print quality would be very useful for paper machine operators. From newsprint to fine art color print editions the image carried by the paper must meet expectations for clarity, uniformity, color balance and intensity, etc. Off line

measurements that predict print quality include smoothness, porosity, gloss, brightness, opacity and shade. Most of these can also be measured on the paper as the machine runs. The critical area is the interaction of the ink or toner with the paper surface. Currently, laboratory printing presses such as the Prufbau are used to measure dot gain and optical density for a given amount of ink applied to the surface. Some critical measures for the following processes are:

- Offset printing—wet picking of fiber from paper to ink carrying blanket. Water hold-out or a resistance to wetting from the ink or fountain solution.

- Rotogravure—micro (50um) scale smoothness. Sheet compressibility.

- Xerography—static charge acceptance/decay rate. Residual stresses leading to mottle and curl.

- Inkjet—ink absorbency. Wetting and feathering leading to smeared images.

Instrumentation that can predict these properties from the moving web on the paper machine could lead to control actions in the stock refining, press loading control, size application areas, for example. Coated paper also presents an opportunity for controlling application rates and variation of chemistry depending on the surface properties.

Non-contacting sensors that rely on optical or boundary layer air flow measurements, for example, would be superior to contacting sensors that could cause disruptions or breaks by interfering with the sheet.

4. <u>Diagnostic Tools</u> (Pathway #2)

The effective operation of pulping and papermaking processes is hampered in many cases by inadequate understanding of the internal process conditions, their dependence on equipment operating parameters and input stream characteristics, and the influence of these process conditions on downstream processes and on final product properties. Effective diagnostic tools are needed to allow researchers to make on-line, in-situ measurements of key process variables in order to elucidate these inter-relationships.

Additionally, troubleshooting to solve mill operational problems is a common activity of technical service personnel in our industry. When a paper machine is not achieving the desired product specifications, or is experiencing frequent sheet breaks, the cause is often a mystery which cannot be solved using the information available from the on-line sensors alone. In order to determine the cause of problems like these, technical service or R&D people have to be able to go out to the mill and gather additional data to determine the root causes of the problems. This often involves the use of diagnostic sensors, devices the trouble-shooter brings along and uses to make measurements unavailable from the on-line process control sensors. These devices may have better accuracy or resolution than the on-line sensors, or they may measure things not measured at all by the on-line sensors. The trouble shooter will then combine the additional information from these diagnostic measurements with an understanding of the process to determine the root cause of the problem. Unfortunately, neither the available diagnostic sensors, nor the current level process understanding are all that we would like them to be.

Sensor and controls vendors would be unlikely to invest significant effort in the development of such diagnostic tools since the market for these devices is quite small. However, the development of diagnostic sensors provides a natural avenue for the demonstration of novel measurements which can

later be adapted for use in on-line process control sensors where appropriate. Furthermore, the value associated with such tools can be substantial, providing the pulp and paper industry with important insights into process dynamics and providing support for the development and validation of theoretical and engineering models.

The development of effective measurement techniques almost always requires an intimate knowledge of the measurement environment, so that the process of diagnostic tool development will spur research that can provide useful insights about that environment by seeking to answer questions that might not otherwise be asked by process engineers or pulp and paper researchers. A few examples of areas where such diagnostic tools would be valuable would include:

- < In-situ digester measurement (flow, temperature, chemistry, chip physical properties, etc.)
- < Spatially resolved, in-situ headbox measurements (consistency, flow patterns, colloid chemistry, etc.)
- < In-situ paper machine forming section measurements (fiber orientation, drainage, fiber bonding, retention, etc.)

5. <u>Sustained Effectiveness of Control Systems</u> (Pathway # 5)

There is a need to develop techniques to ensure that control system performance and economic benefits do not deteriorate over time. This will allow a control system to provide uninterrupted improved performance. Our systems continue to increase in complexity, depending heavily on software and hardware (sensor) performance. While outstanding improvements in performance otherwise impossible are sometimes achieved, the production of the mill can be dependent on these systems. Techniques are needed to compare on-going operation with benchmarks, specifications, or past accomplishments to quickly identify performance degradation. On-line systems that monitor the performance of control loops, actuators, and supervisory systems are desired. The early detection of issues that require maintenance and engineering attention will allow the process to continually operate in a high efficiency region. Proposals should identify a specific process area where the research will be targeted. However, results must be able to be generalized to other industry process units.

Sensors & Control Funded Projects

Introductory Remarks: The DOE funded projects listed below (past and present) are provided to give you a better understanding of the research programs that met the needs of the Sensors and Control target areas.

Refiner Disc Gap and Wear Measurement Method
Dynametrics

On Machine Ultrasonic Sensors for Paper Stiffness
Institute for Paper Science and Technology

Development of Feedstock to Product Characterization Tools for the Wood and Pulp Industry
NREL/Ames

Real-time Wood Chip Moisture content Cross Direction Measurement of Web Caliper and Basis Weight by Magnetics
LBNL

Contactless Real-time Monitoring of Paper Mechanical Behavior during Papermaking
Institute for Paper Science and Technology

4-D Characterization of Paper Web at the Wet End
ORNL

Linescan Camera System for On-line Moisture Measurement
LLNL

Non-contact Laser Acoustic Sensor for On-line Measurement of Paper Stiffness
LBNL

Distributed Fiber Optic Sensor for On-line Measurement of Paper Basis Weight
PNNL

ATTACHMENT 2

TWO-PAGE PROPOSAL SUBMITTAL FORM

SENSORS & CONTROL PROPOSAL AREA

PROJECT TITLE

PRIMARY INVESTIGATOR AND COLLABORATORS:

BACKGROUND:

OBJECTIVES:

ATTACHMENT 2

TWO-PAGE PROPOSAL SUBMITTAL FORM (CONT.)

GENERAL EXPERIMENTAL APPROACH:

BENEFITS TO THE INDUSTRY SHOULD THE RESEARCH YIELD PROMISING RESULTS:

APPROXIMATE SCHEDULE:

APPROXIMATE BUDGET AND SOURCES OF FUNDING FOR 1 YEAR AND OVERALL: